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The Effect of Dynamic Software on Prospective Mathematics Teachers' Perceptions Regarding Information and Communication Technology

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Abstract: The aim of this study was to determine the effect of dynamic software on prospective mathematics teachers' perception levels regarding information and communication technology (ICT). The study was conducted to senior prospective teachers studying in a department of secondary mathematics education. The data of the study used both quantitative and qualitative research approaches have been obtained using two different tests, namely "Technology Perception Scale" and "Computer Assisted Mathematics Instruction Perception Scale". Consequently, it has been observed in the study that learning how to use dynamic software positively affects prospective mathematics teachers' perception levels in a statistically significant way regarding the use of technology in education. In addition, at the end of the study, almost all prospective mathematics teachers were of the opinion that mathematical software will contribute to teaching activities, and they have added that such a contribution will manifest itself in visualization, concretization and result in more effective teaching.

Introduction

Referring to all technology used in performing the phases of processing, producing, using, sharing and spreading information as ICT, Baki (2008) states that this technology is based upon computer technology. According to Aydın (2005), the influence of computer technology on education appears to be more extensive in mathematics compared to all other disciplines. This may result from the close connection that exists between the two disciplines. Indeed, computer science was previously a branch of mathematics, becoming a separate discipline later (Aydın, 2005).

The fact that technology is becoming an increasingly more integral part of our daily lives encourages mathematics educators to integrate technology into teaching methods. In order to bring a concrete and experimental approach to mathematical subjects, technology can be utilized in elementary grades. As a consequence, this makes it possible for students to achieve greater success via a more symbolic and abstract approach in school later (Flores, 2002). When ICT is mentioned in mathematics teaching, it specifically refers to teaching performed using computer-based cognitive tools (Baki, 2008). The role of the computer in mathematics teaching and learning is becoming more and more important to a degree that it is now regarded as imperative and will lay the foundation for the advancement of mathematics education (Wiest, 2001).

Apart from the fact that the success of computer assisted mathematics instruction in learning-teaching processes depends on a range of variables, providing lesson software that is appropriate for educational aims and objectives is important for the method to succeed (Uşun,

2004). This being the case, software becomes one of the important elements of computer-assisted instruction. In order to achieve success in computer assisted mathematics instruction, one must choose software appropriate to the topic that will be covered in the course.

Mathematical software packages have progressed extensively over the course of the last few decades (Lavicza & Papp-Varga, 2010). Amongst a host of software available to assist in the teaching and learning of mathematics, two well-known forms are "computer algebra systems" and "dynamic geometry software" (Hohenwarter & Jones, 2007). According to Hohenwarter and Fuchs (2005), dynamic geometry and computer algebra systems have greatly affected mathematics education. Unfortunately, these instruments have remained completely unconnected. GeoGebra is a software system that combines the potential for both computer algebra and dynamic geometry in one instrument for mathematics education (Hohenwarter & Fuchs, 2005). GeoGebra software provides significant teaching and learning opportunities for teachers and students in calculus, geometry and algebra at every stage of learning, from elementary to higher education. The software concurrently gives the algebraic, graphic and spreadsheet representation of mathematical objects. Any changes made to one of these aspects are directly reflected in the others. Karadag and McDougall (2009) state that GeoGebra users, whether students or teachers, can utilize this setting in order to elucidate, discover and model mathematical concepts and interactions between mathematical concepts or mathematics as a whole. With this software, students can discover mathematical concepts without the need to spend a great deal of classroom time on drawing figures, objects or functions, and in addition, they are able to dynamically associate algebraic, graphic and numeric representations of these concepts (Haciomeroglu, Bu, Schoen, & Hohenwarter, 2009). GeoGebra is freely downloadable software from its website (www.geogebra.org).

It has been observed in previous studies that ICT in general, and mathematical software in particular, have a positive effect on achievement (Bate, Day, & Macnish, 2013; Leikin & Grossman, 2013; Dikovic 2009; Ross & Bruce, 2009), motivation (Aktümen & Kaçar, 2008; Lopez-Morteo & Lo´pez, 2007; Machin & Rivero, 2002) and retention (Pilli, 2008) in mathematics learning. Additionally, Gao, Wong, Choy and Wu (2010) state that prospective teachers can learn to teach with ICT. Thus, the integration of ICT in the education environment is considerably important for mathematics education. Teachers play an effective role in maintaining this integration. Therefore, examining teachers' perceptions regarding ICT is a significant step for education. The aim of this study is to determine the effect of dynamic mathematics software (GeoGebra) on prospective mathematics teachers' perception levels regarding ICT.

Method

The embedded design, which is one of mixed methods designs comprising both quantitative and qualitative methods, was used to conduct the study. In the embedded design, it is collected quantitative and qualitative data simultaneously or sequentially, but these data forms have a supportive role for each other (Creswell, 2011).

The quantitative part of the study has the single group pretest-posttest design. In this design, one group of subjects is given a pretest, then the treatment, and then the posttest (see Table 1). The pretest and posttest are the same.

A qualitative research approach is employed to thoroughly analyze a situation in the research. In the qualitative part of the study, it is used a case study. The Case study is an in-depth analysis of a situation (McMillan & Schumacher, 2010). The qualitative part of this study consists of prospective teachers' opinions.

Participants

The sample of this study is composed of 33 volunteer senior prospective teachers studying in the department of secondary education mathematics teaching at a faculty of education in Turkey.

Data Collection Instruments

The data of the study have been obtained, primarily, via two scales, namely, the Technology Perception Scale (T_1) and the Computer Assisted Mathematics Instruction Perception Scale (T_2).

The Technology Perception Scale is a 5-point Likert-type scale from 1 (strongly disagree) to 5 (strongly agree) comprising 28 items, developed by Tınmaz (2004) in the Turkish language, for measuring prospective mathematics teachers' perceptions regarding the use of technology in education. Scores are obtained by the addition of points across items. The higher the scores achieved in the scale, the more positive the individual's perception regarding the use of technology. The Cronbach alpha coefficient of the scale was calculated as 0.86 by Tınmaz (2004). Three of the 28 items in the scale were omitted since they were not related to the first sub-problem of the study. Sample items for the scale include "Computers should be used in education", "The use of technology in education increases the success of students", "The budget allocated for the use of technology in education is a good investment for the future", "The use of technology in the classroom improves the quality of education" and "The use of technology in the classroom enriches the course curriculum". In the present study, the alpha reliability coefficient of the scale is 0.87.

The Computer Assisted Mathematics Instruction Perception Scale (T_2) comprises a total of 8 items (two demographic question forms and six open-ended questions) formed by the researcher in order to qualitatively determine prospective mathematics teachers' perceptions regarding computer assisted mathematics instruction. Demographic questions in T_2 are as follows; "How many mathematics-related software packages (programs) had you heard of before participating in this study? Write the names of these programs." and "What are the lessons in relation to computers you have taken during your undergraduate education? and, in this process, have you been taught any mathematics software?" Open-ended questions in T_2 are given below;

- In your opinion, can mathematics software assist the teacher in educational activities? If so, how?
- In your opinion, can mathematics software contribute to learning? If so, how?
- Must technology be integrated into high school mathematics courses? What are your opinions and suggestions regarding this issue?
- What are your thoughts on the adequacy of courses you took during your undergraduate education for performing computer assisted mathematics instruction? What do you suggest regarding this issue?
- How does the use of this software (GeoGebra) in mathematics courses affect students' learning?
- If you have something to add in regard to the issue, please elaborate

Procedure

The study was conducted in a computer laboratory over a two-week period. The laboratory environment was arranged so that each prospective mathematics teacher in the sample used one computer. The study was planned as a set of eight 50 minutes sessions on the dynamic mathematics software GeoGebra. The study plan is given in Table 1.

Sessions	*Activities*
1st session	- General information about the study - Application of T_1 as a pre-test
2nd session	- General information about computer assisted instruction and mathematics software - Examination of the tools in GeoGebra - Presentation of algebra and spreadsheet views
3rd session	- Drawing of a point, line and segment - Showing the intersection of two objects - Drawing of a perpendicular line, parallel line, perpendicular bisector and angle bisector - Drawing of a polygon and a regular polygon
4th session	- Construction of a slider - Drawing of a circle and connecting the slider to radius of a circle - Construction of an angle and connecting the slider to an angle - Reflecting object about line and point
5th session	- Construction of the parabola $f(x) = ax^2 + bx + c$ by connecting each slider to its coefficients - Construction of a function and its first and second derivative in the drawing pad - Showing trigonometric functions in a unit circle
6th session	- Construction of the graph of trigonometric functions - Construction of the inscribed and central angle in the same arc in a circle
7th session	- The areas of a triangle with equal base and height. - Drawing of a tangent line to a curve from a point. - Construction of lower sum, upper sum and Riemann sum
8th session	- Application of T_1 as a post-test - Application of T_2

Table 1: The study plan

Prior to the sessions, prospective mathematics teachers were told that they did not need to write their names on the scales used in the study, that they could write random codes that would need to be used for all data collection instruments of the study. The sessions stated in Table 1 were given by the researcher. GeoGebra applications, which were a feature of the sessions, were presented by the researcher via projection from his own computer. The prospective mathematics teachers performed these applications step by step with the researcher using their own computers. Technical support was given to teachers who had problems in performing the applications. Studies by Hohenwarter, Hohenwarter, Kreis and Lavicza (2008), Hohenwarter, Hohenwarter and Lavicza (2008), and Haciomeroglu et al. (2009) were utilized in forming calculus and geometry applications in this study. Parabolas, the inscribed-central angle and Riemann sums were amongst some of the applications used and are given below in Figures 1, 2 and 3.

The view of the GeoGebra file, which has been prepared to dynamically see the change occurring in the graph of the parabola as the coefficients of the parabola change, is given in Figure 1.

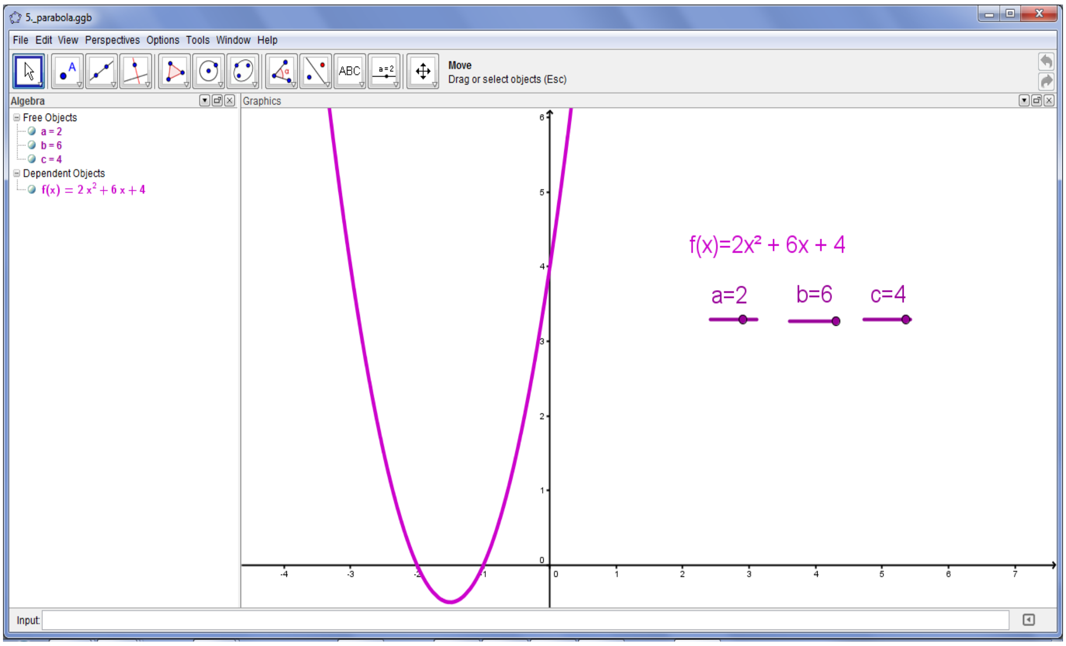

Figure 1: A view of the material for parabola

The statement that the measure of an inscribed angle is half the measure of the central angle with the same intercepted arc is a conjecture in circle geometry. The view of the GeoGebra file, which has been prepared to dynamically see this conjecture given the relationship between a central angle and an angle inscribed in the same arc, is shown in Figure 2. In the GeoGebra material, inscribed and central angle can be changed optionally by means of β-slider.

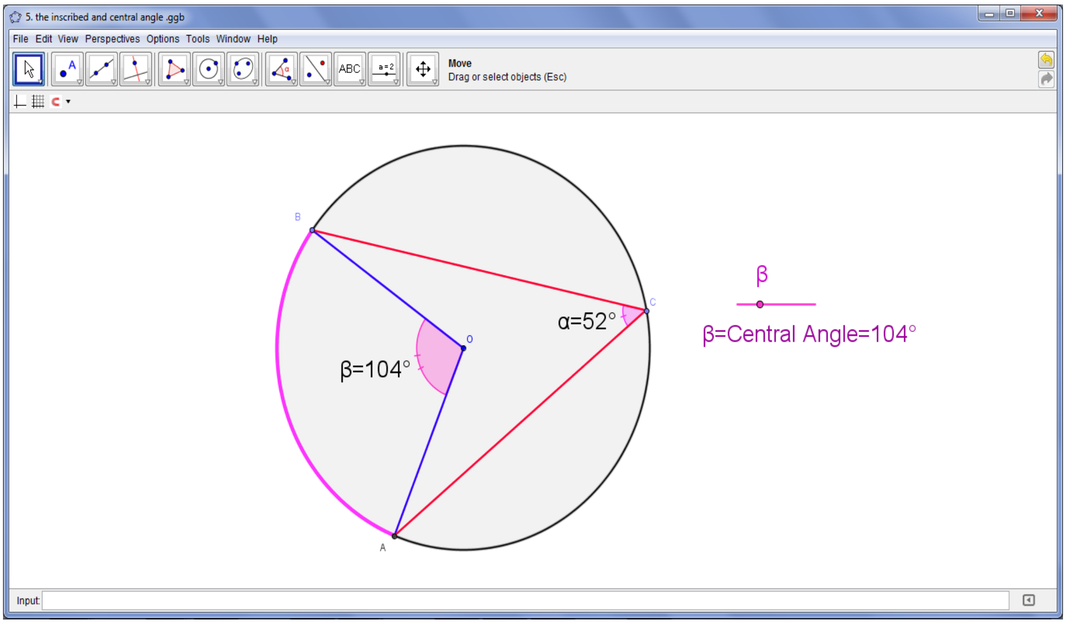

Figure 2: A view of the material for the inscribed and central angle

In Figure 3, we can see how the GeoGebra file has been prepared to ensure that the concept of the Riemann sum is fully understood. Here, lower sums and upper sums, which occur when the section of a function that falls between the [a, b] closed interval and the x-axis is divided into n equal parts, can be calculated. The values n, a and b can be dynamically changed optionally by means of sliders which have been formed in this material.

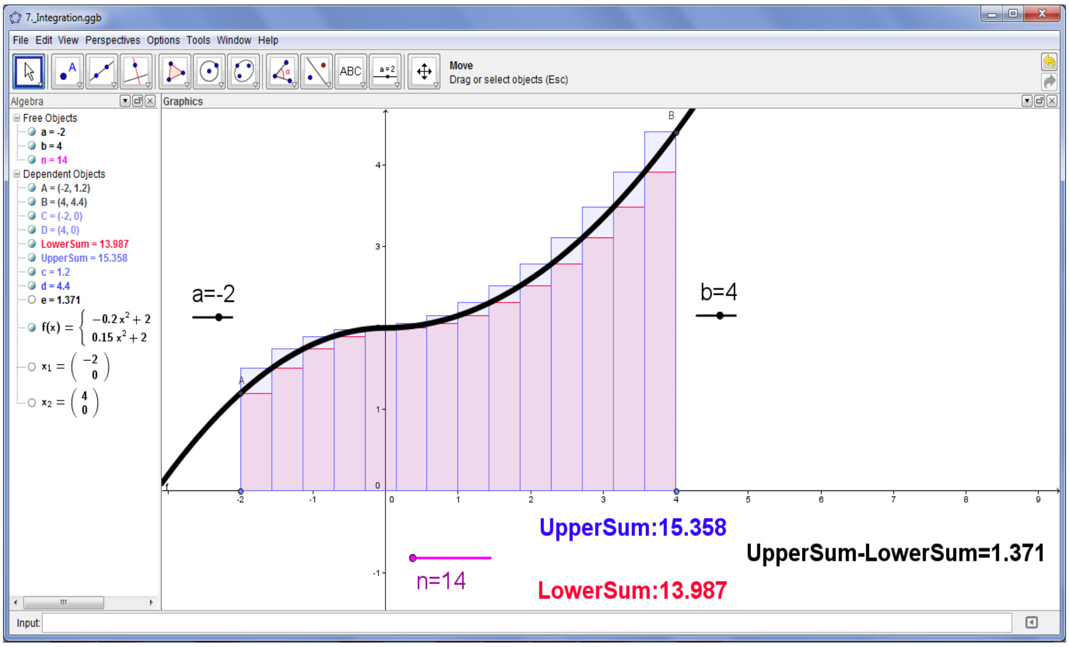

Figure 3: A view of the material for Riemann sum

Data Analysis

A total of 36 prospective mathematics teachers participated in the pre-test used in the study. Three of these prospective teachers did not participate in the post-tests. The data analyzed were taken from the 33 prospective mathematics teachers who participated in both the pre- and post-tests.

The analyzing was done using the SPSS 20 program for Windows and the significance level (two-tailed) was set to 0.05 since it is the most used value in educational studies. Since the sample of this study comprised less than 50 members, the Shapiro-Wilk test was used to understand whether qualitative data obtained from the pre- and post-test T_1 were normally distributed (Büyüköztürk, 2011). Furthermore, Q-Q plot, and box and whisker plot were also examined (Field, 2009). As the data was normally distributed, the paired samples t-test was performed to test whether there was a significant difference between data obtained from the pre- and post-test T_1.

Both content analysis and descriptive analysis were conducted in order to analyze the qualitative data obtained from the T_2 test. Prospective mathematics teachers' answers to each question in the scale were individually coded, categorized and presented as tables containing frequencies and percentages. Categories expressed by at least two people were included in the tables. Furthermore, sample references from the prospective teachers, which were coded in a range from PT1 to PT33, were featured in relation to the formed categories.

Results

The effect of dynamic mathematics software on prospective mathematics teachers' perception levels regarding ICT was examined using data from both the Likert type test (T_1) and the test (T_2), which is composed of open-ended questions.

The Effect of Dynamic Software on Perception Regarding the Use of Technology

The prospective mathematics teachers' scores in the T_1 test, which was used as both the pre- and post-test, were examined to determine whether there was a statistically significant difference. Shapiro-Wilk test ($p_{pre\text{-}test}>.05$; $p_{post\text{-}test}>.05$), Q-Q plot, and box and whisker plot, showed that quantitative data obtained as a result of both pre-test and post-test had normal distribution. Accordingly, the results of Paired Samples t-test, which is a parametric test used for identifying whether there is a significant difference between the tests, are given in Table 2.

Test	N	Mean	SD	Df	t	p
Pre-test (T_1)	33	89.97	12.58	32	6.237	.000
Post-test (T_1)	33	101.42	9.51			

Table 2: Paired Sample t-Test for perception regarding the use of technology (The maximum value for T_1-test is 125)

The results of the conducted paired samples t-test show that there is a statistically significant difference ($t_{(32)}=6.237$, $p=0.000<0.05$) between pre-test and post-test in terms of prospective mathematics teachers' perception levels regarding technology. While the technology perception test average of prospective teachers was 89.97 before the treatment, this average rose to 101.42 after the treatment. In other words, it was established that teaching GeoGebra has a statistically significant effect in raising prospective mathematics teachers' perception levels regarding the use of technology.

Prospective Mathematics Teachers' Perceptions Regarding Computer Assisted Mathematics Instruction

This section presents an analysis of each answer given by the prospective mathematics teachers to the questions in the T_2 test applied as the post-test in the research.

- Prospective teachers were then asked, *"How many mathematics-related software packages (programs) had you heard of before participating in this study? Write the names of these programs."* two prospective teachers stated that they had heard of four programs; five prospective teachers had heard of three; eight of the prospective teachers said they had heard of two of the programs; fourteen stated they had heard of one program; and six prospective teachers had not heard of any programs. Table 3 shows the software named by the prospective teachers and the number of prospective teachers who mentioned it.

Software	Number of prospective teachers
MathType	24 (73%)
Matlab	10 (30%)
GeoGebra	7 (21%)
Scientific Workplace	6 (18%)
Cabri	2 (6%)
C++	2 (6%)
Maple	1 (3%)
Mathematica	1 (3%)

Table 3: Software names recognized by prospective mathematics teachers

- In response to the question, *"What are the lessons in relation to computers you have taken during your undergraduate education? and, in this process, have you been taught any*

mathematics software?" all of the prospective teachers stated that they had taken only two basic computer courses, namely Introduction to Computer-1 and Introduction to Computer-2. These courses cover computer literacy, Word, Excel and PowerPoint. In addition, they said that there were no courses available to them in which mathematics software was taught, during their undergraduate education.

- When asked, *"In your opinion, can mathematics software assist the teacher in educational activities? If so, how?"* 31 of the 33 candidates stated that there would be a contribution. The details of what this contribution entails are given in Table 4.

Categories	f (%)
Convenient visualization	12 (36%)
Convenient concretization	8 (24%)
Facilitates the work of teachers in courses	8 (24%)
Facilitates an eager teaching attitude	2 (6%)
Facilitates a more effective teaching performance	2 (6%)
Eliminates the need for expressions such as *"let's assume"*, *"let's presume"*, and *"suppose that"*	2 (6%)

Table 4: Benefits of software for teachers

PT27, who used the concretization expression given in the Table, answered this question as follows:

> *"These programs, which constitute a perfect force in concretizing what is taught, make a contribution by providing remarkable convenience and by clarifying understanding and thinking."*

PT5 stated that the use of expressions such as *"let's assume"* and *"suppose that"*, which are frequently used by mathematicians while teaching a course, will not be needed much thanks to such software. In his words:

> *"I definitely believe that it will make a contribution. This gives us the opportunity to use expressions like 'let's assume', 'let's presume' and 'suppose that' less, and open the program and work with concrete realities instead of using these expressions."*

PT24 made the following statement regarding the eagerness of the teachers while teaching courses:

> *"Teachers can rid the course of monotony thanks to these software packages and they, in turn, become more eager to teach the course. They take more pleasure in what they do. Accordingly, the quality of their teaching activities increases."*

- The question *"In your opinion, can mathematics software contribute to learning? If so, how?"* was then asked. 32 of the 33 prospective teachers stated that there would be a contribution. Only one prospective teachers did not answer the question. The details of this contribution are summarized in Table 5 :

Categories	f (%)
Increased retention	19 (58%)
Facilitates learning	11 (33%)
Evokes eagerness towards learning	9 (27%)
Provides an enjoyable and entertaining learning environment	6 (18%)

Table 5: Prospective teachers' perceptions of benefits of software for learning

PT8, who stated in his/her response to this question that software will contribute to learning in terms of retention, added the following:

"It will make a contribution. Instead of a learning based on memorization that can be easily forgotten, the software helps to make the learning a lasting experience. Students learn mathematics visually. All the information learned through the software is connected in our minds instead of existing somewhere in stacks. Most importantly, we can answer questions like 'What am I doing and for what?', 'How will the information be constructed?' in abstract mathematics with these software packages."

Explanations given by PT11 and PT22, who believed that mathematics software will contribute to evoking eagerness and interest towards learning and in forming an enjoyable and entertaining learning environment, were respectively as follows:

"I believe that such software packages will rid mathematics learning of its boringness in the eyes of students since they will generally catch the attention of students."

"Students learn by doing-performing by themselves and easily concretize mathematics in their minds. Students enjoy the course while learning, and they may become more eager."

- Among the answers given to the question *"Must technology be integrated into high school mathematics courses? What are your opinions and suggestions regarding this issue?"* only three of the prospective mathematics teachers stated that this integration is difficult owing to socio-economic reasons. The remaining 30 prospective mathematics teachers stated that technology must be integrated into high school mathematics courses; their opinions and suggestions are given in Table 6.

	Categories	f (%)
Opinions	Technology, which facilitates life in general, will transform mathematics into a popular lesson by making it easy.	6 (18%)
	Technology must be integrated for an enjoyable and more educative learning environment.	2 (6%)
Suggestions	Teacher training must be provided regarding this issue.	9 (27%)
	Technology classrooms must be formed, and courses must take place in these classrooms.	6 (18%)
	Software must be used in teaching topics.	5 (15%)
	Technological support must be provided for students.	2 (6%)
	Teachers must be encouraged to use the programs.	2 (6%)

Table 6: Opinions and suggestions regarding the integration of technology into mathematics

In answer to this question, PT6, PT11 and PT32 suggested teacher training be provided and technology classrooms be formed, stating, respectively:

"This integration will be possible through developing programs like GeoGebra and through educators learning how to use these programs."

"Technology classrooms must be formed and teachers must be trained on how to use such software on in-service training courses."

"Just like some physics and chemistry courses which are given in laboratories, a number of mathematics courses can be given in computer laboratories or technology classrooms."

Emphasizing the close relationship between technology and mathematics, PT32:

"While living in the age of technology, it would be meaningless to dissociate mathematics. Indeed, mathematics is a prerequisite for technology. We can provide retention in learning, keep up with the developing world and eliminate disagreements by integrating technology into mathematics courses."

- In response to the question *"What are your thoughts on the adequacy of courses you took during your undergraduate education for performing computer assisted mathematics instruction? What do you suggest regarding this issue?* only one prospective teacher answered, *"They are adequate"* and 26 of the 33 prospective teachers answered, "They are not adequate". 12 of the 26 prospective teachers presented suggestions regarding this issue. Their suggestions are categorized in the Table 7.

Categories	f (%)
Courses must be given on mathematics software, such as GeoGebra.	7 (21%)
Technology courses must feature more in the curriculum.	3 (9%)
Courses must be given on ICT and Computer Assisted Mathematics Instruction	2 (6%)

Table 7: The opinions of prospective mathematics teachers regarding technology-related courses undertaken in their undergraduate education.

PT8 gave the answer *"They are not adequate"* to this question, stating:

> *"At least several field courses undertaken in the undergraduate program must be given with computer assistance. There must be lessons in which mathematics software is taught."*

Another prospective mathematics teacher who also gave the answer *"They are not adequate"* is PT21. He stated the following in regard to the undergraduate education that he experienced:

> *"I did not learn anything about computer assisted mathematics instruction during the course of my undergraduate education. I think courses in which computer assisted mathematics instruction is taught must be included in the undergraduate curriculum."*

Mentioning the computer knowledge he gained during his undergraduate education, PT32 answered this question in the scale as follows:

> *"They are not adequate. My computer knowledge gained so far consists of Word and Excel. It is clear that this knowledge solely will not be adequate in my using* ICT *in an effective manner. However, the software packages which are used in mathematics teaching will definitely be useful if they are given."*

- Answers to the question *"How does the use of this software (GeoGebra) in mathematics courses affect students' learning?"* are shown in Figure 4.

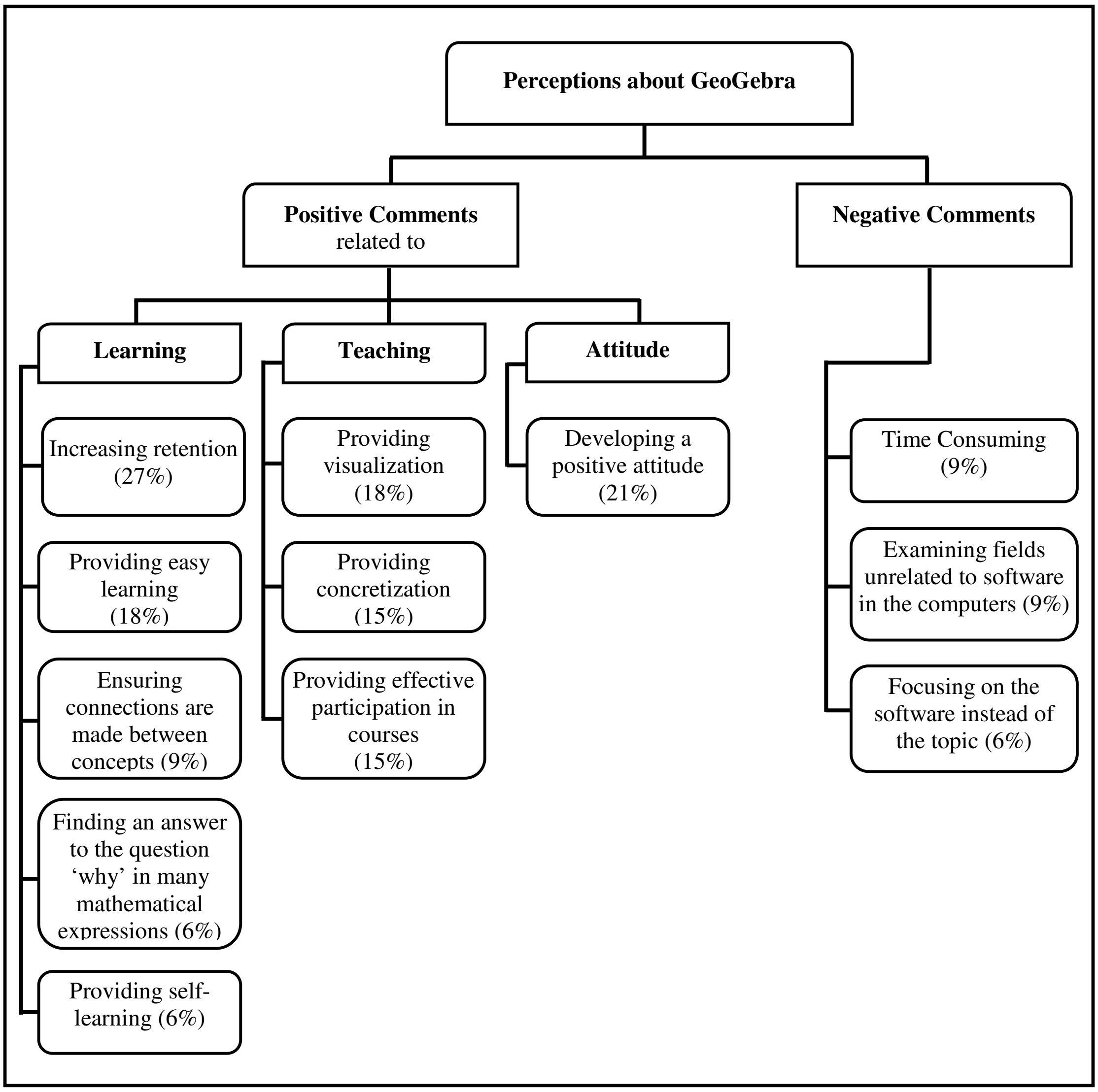

Figure 4: Prospective mathematics teachers' perceptions about GeoGebra

PT10 and PT14 respectively stated both the positive and negative aspects of using GeoGebra in lessons in terms of students' learning as follows:

> *"Positive: It makes students develop a positive attitude towards mathematics. It makes students learn hard-to-understand topics. It rids the courses of their boringness. It shortens the time in which theoretical information is learned. It creates extra time to put the theoretical information into practice. It raises the interest of the student towards the course.*
> *Negative: There may arise problems if the students are not supervised when they are using the computers. It may not be possible to apply this teaching to students whose backgrounds are insufficient for computer assisted instruction."*
> *"Positive: With GeoGebra, students can learn by themselves. Mathematics can be rid of its abstractness. Answers to the question 'why' can be found for many mathematical expressions. Many things can be learned in a short space of time.*
> *Negative: Students can lose self-confidence if they cannot learn how to use the software. If the students do not have their own computers at home, there*

will not be reinforcement since they will use the software only at school, and what is learned will be jumbled."

In their answers to this question, PT22, PT25 and PT30 mentioned only the positive aspects given respectively as follows:

"It will definitely have a positive effect. Showing students that they can do something by themselves will be very effective at times where students are rather bored with plain explanations. Many students' viewpoints, interest and attitudes towards mathematics will change in a positive way."

"The difficulty experienced by students in envisaging the given topic will be eliminated. Participation will increase since the courses will become more enjoyable. Retention increases and learning becomes easier."

"Following this GeoGebra course, I have observed that it concretized a great deal of information that I considered to be abstract. Undoubtedly, it is evident that concrete information can be more easily assimilated compared to abstract forms."

- Lastly, there is a section in the Computer Assisted Mathematics Instruction Perception Scale stating, *"If you have something to add in regard to the issue, please elaborate"*. In addition to the questions, the analysis of which is given above, prospective mathematics teachers made the statements given in the Table 8.

Prospective Teacher	Quotation
PT2	*I will be a mathematics teacher in about two weeks. Unfortunately, I did not hear of such a program during my undergraduate education. It is a very useful and practical program. I want it to be taught to all teachers and students.*
PT9	*I do not know whether there is a GeoGebra group or website, but if not, one can be set up. The software applications can be shared through such group or website. For instance, let's say I'm going to teach the 'limit' topic but I have not yet been able to do it on the program, I can visit the website and download ready-made GeoGebra files from there.*
PT10	*You can guess how many times we came across the concept of Riemann sum during our undergraduate education. After seeing the Riemann application in GeoGebra, I want to say that I wish our Analysis teacher had taught this topic using this application, but I am not sure if he had heard of the software then. I have to admit that I now have a better understanding of Riemann, and accordingly, definite integral logic.*
PT14	*This software must definitely be taught during undergraduate education. If this software had been actively used in our courses, for instance in analysis and geometry, the knowledge acquired and our understanding of the courses would have been long-lasting.*
PT30	*Since there are very few students who do not have experience in using a computer and who do not enjoy computers, using such software can be attention-grabbing in a course such as mathematics, which is not liked by students.*
PT8	*Students must not be excluded from this process in view of the progress of computer technology. Moreover, it would be exciting to see a problem with a long and detailed solution being solved with this software.*
PT10	*While there are technical possibilities to prevent mathematics from being a nightmarish field, if we do not benefit from such possibilities, we cannot keep up with the times. Such software will make mathematics easier for students to understand, and make students self-confident and actually like the course.*

Table 8: Other statements added by prospective mathematics teachers about the issue

Discussions and Recommendations

Firstly, the effect of dynamic mathematics software on prospective mathematics teachers' perceptions about using ICT has been examined in this study. As a result of the conducted study, it has been observed that learning using the software has a statistically significant effect in raising prospective mathematics teachers' technology perception levels. This result supports the results of Stols and Kriek (2011).

Secondly, an attempt has been made to closely examine prospective mathematics teachers' perceptions regarding computer assisted mathematics instruction. Following the application, almost all prospective mathematics teachers stated that mathematics software will contribute to teachers in teaching activities. This result explains the statistically significant change in prospective mathematics teachers' technology perception levels following this application. Prospective mathematics teachers have asserted that the contribution of software to teachers will manifest itself in visualization, concretization and achieving a more effective teaching. Furthermore, They also state that software contributes to learning by giving answer such as "it increases retention", "it facilitates learning", "it evokes eagerness towards learning" and "it provides an enjoyable and entertaining learning environment". These contributions, identified by the prospective mathematics teachers, are among the most important reasons for using a computer-equipped environment in mathematics teaching, as stated in the studies of Choi-Koh (1999), Seo and Woo (2010), Tezer and Kanbul (2009), and Wang (2011).

All participants of this study have stated that they took Introduction to Computer-I and Introduction to Computer-II courses in which only basic computer skills were gained in relation to computers during their university education, and there were no courses available to them in which mathematics software was taught. In other words, the GeoGebra they learned in this study was the first instance of mathematics-related software they had encountered during their education. Although the majority of the prospective mathematics teachers who participated in the study stated that technology must be integrated into mathematics courses, they believed that lessons given during their university education were not adequate enough to enable them to perform computer assisted mathematics instruction themselves. Teachers must be trained and encouraged in order to actualize the integration of technology into mathematics courses. Moreover, prospective mathematics teachers have mentioned that at least several field courses, taken during their education in the faculty, must be given with computer assistance. On this issue, Baki (2002) stated that if the prospective teachers are required to perform high quality teaching, they must get the same quality education in faculties. He added that if prospective teachers do not gain experience related to computer assisted environments during their pre-service years, or if teachers do not gain the same experiences via in-service training, they cannot be expected to perform proper computer assisted mathematics instruction. Teachers are naturally inclined to subject their students to the same processes they experienced in mathematics courses when they were students (Baki 2002).

Prospective mathematics teachers disclosed the fact that through the GeoGebra application experienced in this study they were now able to easily understand concepts such as lower sum, upper sum and Riemann sum, which previously they had simply memorized or remained uncertain about. Thanks to the software, they could directly concretize instead of using expressions such as *"let's assume"* or *"suppose that"* especially while teaching these concepts.

Teacher training is an extremely significant issue that is frequently mentioned in regard to the rising use of technology in teaching. Thus, we must present a solid endeavor to maintain constant and high quality teacher training in terms of technology use at pre-service

levels as well as in-service levels (Wiest, 2001). Although the use of only one of the dynamic software packages was examined in this study, a positive change was observed in prospective mathematics teachers' perceptions about using ICT. Therefore, computer assisted mathematics instruction courses, in which dynamic mathematics or geometry software is taught, must be included in the curriculum of mathematics teaching departments. Via in-service training programs, in-service teachers must be supplied with necessary information regarding the environment in which these software packages are used.

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